

How change in cost of capital motivates companies to go green?

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Abstract

This literature review examines how cost of capital effects on companies' willingness to change their behavior towards green activity. There have been studies before which have examined green companies' performance compared to polluting entities. Robert Heinkel, Alan Kraus, and Josef Zechner, 2001 have found evidence on Journal of financial and quantitative analyses, that people will require higher expected return on firms which are polluting. They used different control variables which included restrictions: Same amount of companies, no short selling, same cash flows, same costs to reform, risk averse investors, Firms maximize share price, 5 percent reforming cost from expected cash flow, one period world, unacceptable and reformed firms have same common technology, all acceptable firms have different technology compared to unacceptable and reformed firms, and returns are normally distributed. Heinkel, Kraus & Zechner, 2001 Stated that there has to be first certain number of green investors until it is plausible to change production technology. This assumption is based on reforming cost versus cost of capital. In equilibrium cost of capital and reforming cost is equal and there are no incentives to reform. There is a strong evidence that firms are going to reform when cost of capital increases above certain level and this increase is affected on the number of green investors in markets. Higher cost of capital implies lower stock price for unreformed companies and therefore they have to make a decision between reforming cost and cost of capital.

Keywords: Cost of Capital, Green investors, Production Technology, Equilibrium

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Introduction

Cost of capital has been long studied factor which contributes on companies' value. Cost of capital is basically a fraction which companies have to pay for having more money. Cost of capital constitutes of equity and debt and both fractions are affecting on total amount of cost of capital. Required rate of return can be viewed as cost of capital hence they are the same thing. This is because other parties require certain return from companies and therefore cost of capital has to be equal to required return. Modigliani & Miller, 1958 stated on their book "The cost of capital, corporation finance and the theory of investment", that cost of capital effects on companies' decision making. Also, Ambec & Lanoie, 2008 concluded that cost of capital is motivating companies for changing their behavior towards sustainable way.

Companies have many functions but one of the most important one is maximizing shareholders value (Modigliani & Miller, 1958). Cost of capital is a function which effects on share price and share price is associated to company's market value. In this sense, corporations should minimize their cost of capital and maximize their share value. There is an incentive to change behavior if there is a function which can reduce corporate's cost of capital. This literature review uses same assumptions as in a study which was conducted by Robert Heinkel, Alan Kraus & Josef Zechner, 2001 on Journal of financial and quantitative analyses. There is a certain cost which we can denote as K and it effects as barrier for companies to change their technology. We can assume that investors are risk averse and they have same risk aversion coefficient. In general, there are two types of investors which have green and neutral preferences towards companies. The world exists one period and companies make their decision to go green¹ in a sense of cost of capital (COC) versus reforming cost (K).

This literature review examines the effect of cost of capital as motivator for companies to change their technology. The number of green investors is a variable, which effects on cost of capital and it will change corporations' way to produce goods for consumers. This study examines this relationship and concludes if there is evidence that relationship exists between number of green investors² and companies' willingness to change their production technology.

This study goes first through hypothesis and research question which is then followed by data and methodology. After that study concludes with future research suggestions.

¹ Green technology is sustainable way to produce products or an improvement from technology which was more pollutive before green technology.

² Green investors are willing to invest in a company which uses technology which is an improvement for previous technology or non-pollutive technology used by the company.

Hypothesis and research question

Hypothesis of this study is that cost of capital motivates companies to change their technology towards sustainable state. There is a certain cost which will restrict companies to change, but if cost of capital increases above this cost, companies start to reform their production technologies. There is a certain number of green investors in markets. This study assumes that number of green investors will increase which will have an effect on polluting companies' cost of capital.

Can cost of capital motivate companies to change their behaviour towards sustainable production? There are many studies which indicate that cost of capital has effect on companies' motives to change their production technology and this thesis examines the magnitude of the effect. Robert Heinkel, Alan Kraus & Josef Zechner, 2001, have thorough study related to the topic and their findings are supporting hypothesis.

Data and methodology

This study utilizes Heinkel, Kraus & Zechner used framework³. Assume two type of investors which are green investors and neutral investors. They have certain cost K which will have an effect on their decision making. All investors have risk-averse preferences and both type of investors share same risk tolerance. At first there are same amount of clean and polluting companies. Short selling is not allowed because of possible arbitrage opportunity. Both Clean (C) and polluting (P) technologies produce same cash flows. Polluting companies have same reforming cost K . Firms in markets are trying to maximize their share value. Unreformed (U) and reformed (R) companies share same common technology and all acceptable (A) firms for green investors have same technology which differs from U and R technologies. Returns are normally distributed in a sense of their mean and variance.

³ Equations are from Robert Heinkel, Alan Kraus, and Josef Zechner (Journal of financial and quantitative analyses 2001).

The number of firms can be expressed as follows;

$$N = N_C + N_P$$

Expressing acceptable and unacceptable firms for green investors;

$$N_C = N_A$$

$$N_P = N_U + N_R$$

Equilibrium for neutral investors as a utility function;

(1)

$$U_n = x_{nA}\mu_C + (x_{nU} + x_{nR})\mu_P - \frac{x_{nA}^2\sigma_C^2 + (x_{nU} + x_{nR})^2\sigma_P^2 + 2x_{nA}(x_{nU} + x_{nR})\sigma_{CP}}{2\tau} \\ - (x_{nA} - \omega_{nA})P_A - (x_{nU} - \omega_{nU})P_U - (x_{nR} - \omega_{nR})P_R$$

Equilibrium for green investors as a utility function;

(2)

$$U_g = x_{gA}\mu_C + x_{gR}\mu_P - \frac{x_{gA}^2\sigma_C^2 + x_{gR}^2\sigma_P^2 + 2x_{gA}x_{gR}\sigma_{CP}}{2\tau} - (x_{gA} - \omega_{gA})P_A \\ - (x_{gR} - \omega_{gR})P_R$$

Where,

- i) x_{ik} is the number of shares of firms of category k (k = A, U, R) held by type I investor
- ii) P_k is the price per share of a firm of category k
- iii) ω_{ik} is the endowment of shares in firms of category k of a type I investor
- iv) μ_k is produced cash flow in category k
- v) τ is aggregate risk tolerance for investors
- vi) P is the price of share k

Optimal portfolio holding for neutral investor comes from taking derivative on U_n with the respect of x_{nA} and x_{nU}

(3)

$$x_{nA} \sigma_C^2 + x_{nU} \sigma_{CP} - \tau (\mu_C - P_A) = 0$$

(4)

$$x_{nA} \sigma_{CP} + x_{nU} \sigma_P^2 - \tau (\mu_P - P_U) = 0$$

Solving simultaneously yields a neutral investor's optimal portfolio holdings,

(5)

$$x_{nA}^* = \frac{\tau}{\phi} [(\mu_C - P_A) \sigma_P^2 - (\mu_P - P_U) \sigma_{CP}]$$

(6)

$$x_{nU}^* = \frac{\tau}{\phi} [(\mu_P - P_U) \sigma_C^2 - (\mu_C - P_A) \sigma_{CP}]$$

$$\text{Where } \phi = \sigma_C^2 \sigma_P^2 - \sigma_{CP}^2$$

First order conditions for green investors;

(7)

$$x_{gA} \sigma_C^2 + x_{gR} \sigma_{CP} - \tau (\mu_C - P_A)$$

(8)

$$x_{gA} \sigma_{CP} + x_{gR} \sigma_P^2 - \tau (\mu_P - P_R)$$

Solving simultaneously yields a green investor's optimal portfolio holdings;

(9)

$$x_{gA}^* = \frac{\tau}{\phi} [(\mu_C - P_A)\sigma_P^2 - (\mu_P - P_R)\sigma_{CP}]$$

(10)

$$x_{gR}^* = \frac{\tau}{\phi} [(\mu_P - P_R)\sigma_C^2 - (\mu_C - P_A)\sigma_{CP}]$$

Equilibrium share prices with market clearing conditions;

(11)

$$I_n x_{nA}^* + I_g x_{gA}^* = N_A = N_C$$

(12)

$$I_n x_{nU}^* = N_U$$

(13)

$$I_g x_{gR}^* = N_R$$

Resulting equilibrium prices are;

(14)

$$P_A = \mu_C - \frac{1}{I\tau} [N_C\sigma_C^2 + N_P\sigma_{CP}]$$

(15)

$$P_U = \mu_P - \frac{1}{I\tau} [N_C\sigma_{CP} + N_U\sigma_P^2 + N_U\frac{I_g\phi}{I_n\sigma_C^2} + N_R\frac{\sigma_{CP}^2}{\sigma_C^2}]$$

(16)

$$P_R = \mu_P - \frac{1}{I\tau} [N_C\sigma_{CP} + N_U\frac{\sigma_{CP}^2}{\sigma_C^2} + N_R\sigma_P^2 + N_R\frac{I_n\phi}{I_g\sigma_C^2}]$$

Number of unacceptable firms that pays to become acceptable equals the price of unacceptable firms plus reforming cost K ;

$$P_R = P_U + K$$

Optimal corporate acceptability choice solving for N_R yields;

(17)

$$N_R = \max \left\{ 0, \frac{I_g}{I} (N - N_C - K I_n \tau \frac{\sigma^2_C}{\phi}) \right\}$$

N_R comes positive in equation (17) when;

(18)

$$I_g^* : N_R > 0 \text{ for } I_g > I_g^*$$

Substituting N_R from Equation (17) into expression P_R yields;

(19)

$$P_R = \mu_P - \frac{1}{I\tau} [N_C \sigma_{CP} + (N - N_C) \sigma_P^2 - K I_n \tau]$$

This helps examine how reformed firm cost of capital changes compared to parameter values.

Results

Results are from the model of Heinkel, Kraus, & Zechner, 2001. This study has used different parameter values than in the original study. Parameter values are presented on the following table:

Assumptions	Value
Mean cash flows	100
Average standard deviation of cash flows	10
Portfolio variance CP	20
Covariance of Cash Flows	50
Reforming Cost	0,5
Total Number of Investors	1
Total Number of Firms	1
Number of Firms with Each Technology	0,5
Investors aggregate risk tolerance	100
Acceptable firm's number of shares	0,3
Unacceptable firm's number of shares	0,5
Reformed firms's number of shares	0,2
Acceptable firm's endowment rate	0
Unacceptable firm's endowment rate	0,2
Reformed firms's endowment rate	0,01

Figure 1.1 Values from figure are used in formulas (14) and (15).

There is evidence based on the model of Heinkel, Kraus & Zechner, 2001, that cost of capital can change when markets will have enough green investors participating. They will make pressure on polluting firms for changing their technology in a sense of decreasing their cost of capital. In a real world, companies can have different reforming costs and that will have an effect on the result. There is also an evidence that companies can increase their productivity when they change their production technology (Wubben, 2000). There is evidence that when companies go green they can sell their technology to other companies (Ambec & Lanoie, 2008). Study also indicates that barriers to enter on new markets decreases, when their production technology is sustainable (Ambec & Lanoie, 2008). Model which is used on this study ignores these aspects.

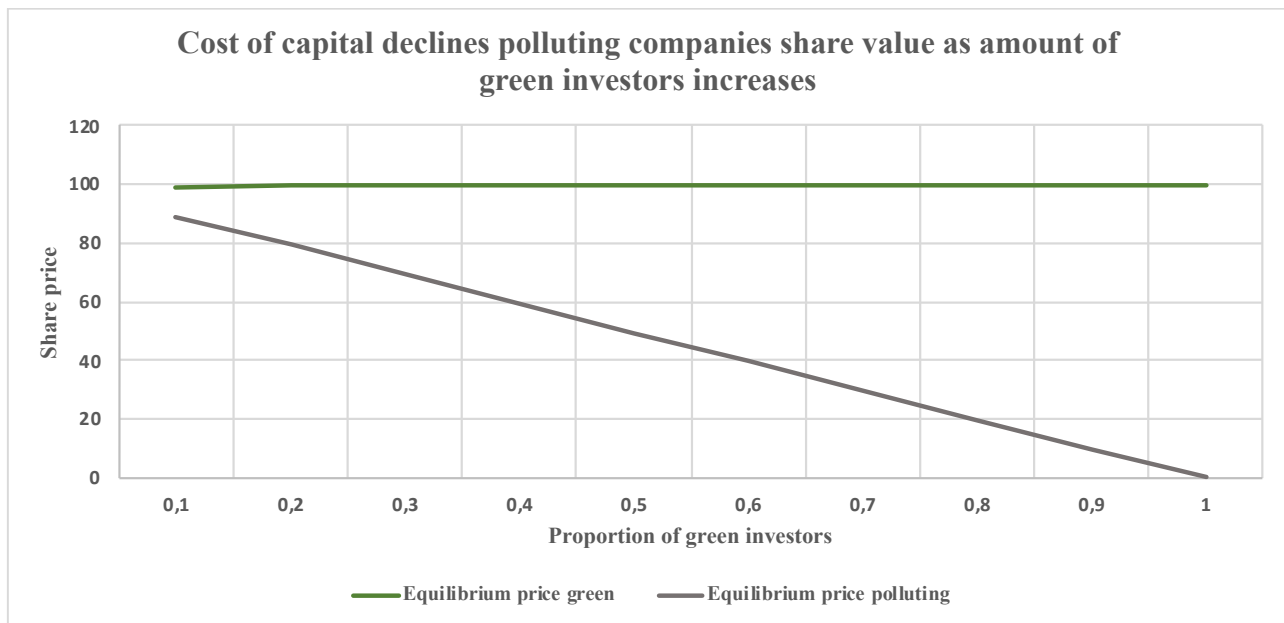


Figure 1.2 Shows how polluting firms share price is declining when amount of green investors increases. Formula's used on calculations are (14), (15).

Figure above illustrates the effect when green investors enter the markets and start to effect on polluting firms cost of capital. Polluting firms share price goes down when green investors demand higher required return on polluting firms. This will decline the share value of polluting firms and increasing the number of reformed firms on markets.

Proportion of green investors	Value K 0,3	Value K 0,5	Value K 0,8	Value K 1
0,1	99,32	99,5	99,77	99,95
0,2	99,29	99,45	99,69	99,85
0,3	99,26	99,4	99,61	99,75
0,4	99,23	99,35	99,53	99,65
0,5	99,2	99,3	99,45	99,55
0,6	99,17	99,25	99,37	99,45
0,7	99,14	99,2	99,29	99,35
0,8	99,11	99,15	99,21	99,25
0,9	99,08	99,1	99,13	99,15
1	99,05	99,05	99,05	99,05

Figure 1.3 illustrates share value sensitivity for reformed firms depended of reforming cost K. Formula used on calculations is formula (19).

Table above shows how reforming cost effects on reformed companies share value. When K is going higher share value of reformed companies is also higher, when amount of green investors is small. This is because, when K is high, companies do not want to reform until cost of capital is equal to K and it is reasonable to change their production technology. Reformed firms have same technology as unwanted firms and therefore the share price of unreformed firms is cost of capital + K compared to reformed firms which share price is simply affected on their cost of capital (Heinkel, Kraus & Zechner, 2001)

Proportion of green investors	Risk aversion 25	Risk aversion 50	Risk aversion 100	Risk aversion 200
0,1	99,1625	99,275	99,5	99,95
0,2	99,15	99,25	99,45	99,85
0,3	99,1375	99,225	99,4	99,75
0,4	99,125	99,2	99,35	99,65
0,5	99,1125	99,175	99,3	99,55
0,6	99,1	99,15	99,25	99,45
0,7	99,0875	99,125	99,2	99,35
0,8	99,075	99,1	99,15	99,25
0,9	99,0625	99,075	99,1	99,15
1	99,05	99,05	99,05	99,05

Figure 1.4 Shows how risk aversion effects on reformed firms share price. Formula used on calculations is formula (19).

Table above shows how in different risk aversion levels reformed firms share price is affected on a function to proportion of green investors. Green investors are willing to lower their required return when their risk aversion coefficient increases, because they can diversify more efficiently on different companies. This explains why reformed companies share price is higher when risk aversion coefficient is high. At the end when there are 100 percent green investors in market, share price is same regardless of risk aversion coefficient. This is because all firms have reformed, and they cannot get lower expected returns compared to other firms, because the model assumes same cash flows and same production technology. Higher risk aversion on green investors motivates companies to change their production technology because they will get lower cost of capital doing so.

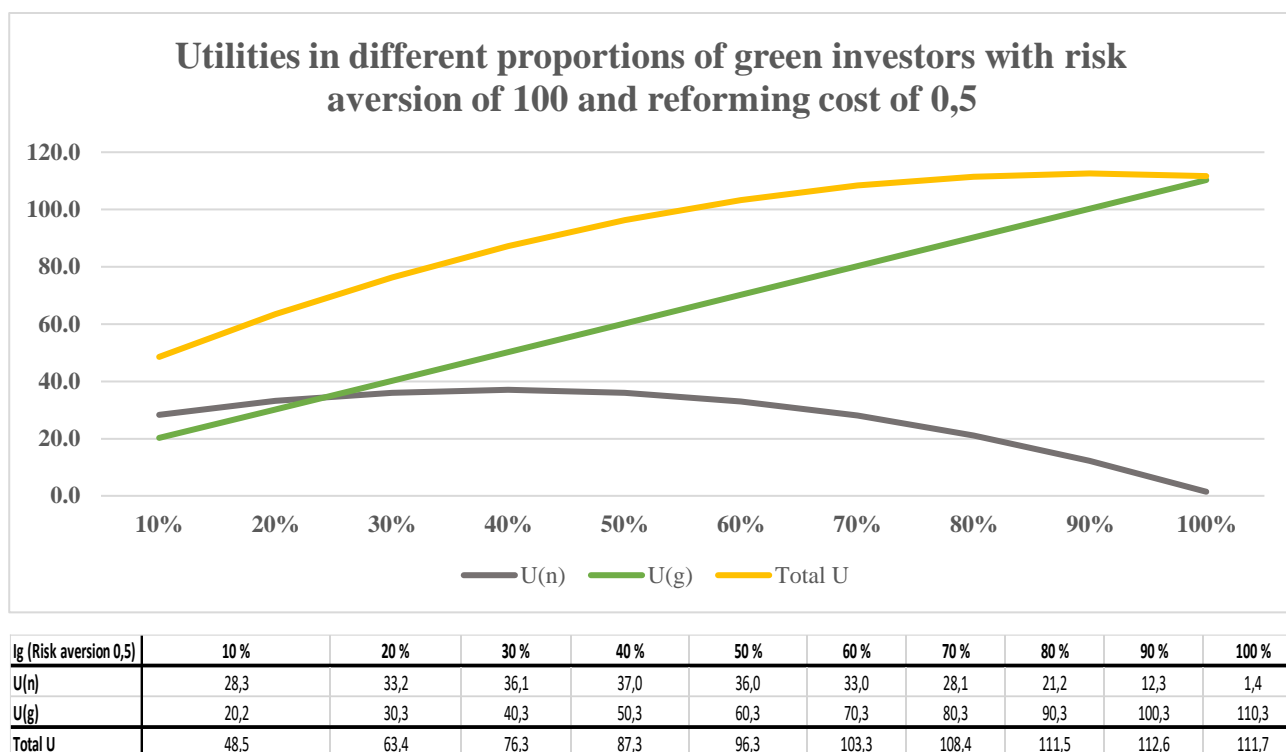


Figure 1.5 illustrates the relationship of the amount of green investors on market and its effect on utilities of green and neutral investors. Formulas used in calculations (1) and (2).

Figure above shows how green investor utility raises approximately one unit per percentage of green investors on market. Total utility is maximized when there are 90 percent of green investors and 10 percent of neutral investors. This is a naïve approximation, but it illustrates the framework of how proportion of green investors can have an effect on total utility on markets. Total utility can have an effect on cost of capital because investors want to maximize their total utility and choose their portfolio which maximizes their level of utility.

It is interesting to consider what is optimal number of green investors and neutral investors on markets. Real number of optimal amount of green investors is dependable of risk aversion coefficient τ , reforming cost K , cash flows of polluting and green firms, covariance's between green and polluting firms cash flows and their endowment rate. There are many variables which are affecting on optimal level and therefore it is impossible to say which is the optimal amount of green investors which maximize investors' total utility.

Conclusion & future research

Through careful review results indicate that cost of capital can act as a motivator for companies to change their production technology towards sustainable way. Companies want to adjust their cost of capital in a lower level, if costs for reform are not too high. In the model of Heinkel, Kraus & Zechner, 2001, which shows in equilibrium that when all companies have reformed which have equal or higher cost of capital compared to K , there is no pressure to reform anymore. There is fixed amount of acceptable and unacceptable firms on markets. In a real world K is different for companies and it can vary through time. This could lead to a point, where all companies eventually become acceptable and polluting companies disappear. The model assumes that reformed companies sustain unacceptable technology and pays premium K to become acceptable. The other option could be that they pay certain amount K and change their technology same as green companies. This would resemble better for reality in sense of acceptability of companies for green investors portfolio. Also, information can have an effect on green companies' stock price. David Lesley & Maureen O'hara, 2004, states that information asymmetries can lead on different share prices and informed investors can utilize this information on their favor. This could lead under allocation of green companies, if information on markets is too restricted and neutral investors cannot utilize this information. The number of green investors is increasing on markets and Morgan Stanley found on their research in 2017 that 75 percent of investors in U.S are interested in sustainable investing and 71 percent of U.S investors are believing that sustainability practices are better in long term investments. These findings indicate that markets are going through changes and firms are starting to reform because there are investors who demand sustainability from companies which they choose to invest in.

In future research there is plenty options to continue. There have been studies which have examined on abstract level of changes in corporate behaviour and their motives to change their technology. The correlation between successful companies and sustainability has been unclear. Is it because wealthy companies can afford their reforming or is it because they have pressure from outside to change and therefore they have to adjust their behaviour towards green economy? This also leads to another question; are green companies successful because they have changed their technology or is it because they are already market leaders, and therefore they could do well, regardless of green technology. These questions need more studies to conduct and future research could reveal interesting results.

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